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WATER CONSERVATION AND IRRIGATION

3. SOME RECENT DEVELOPMENTS IN THE MEASUREMENT OF AUSTRALIA'S WATER RESOURCES*

1. Introduction

There has been a growing awareness in recent years that Australia does not have a reliable estimate of how much water is now available, and how much will be available in the future. Such an estimate is necessary so that the planning of water resources development projects can proceed on a sound basis. With the establishment of the Australian Water Resources Council in 1962 (see para. 5, p. 230) a means was provided of securing the highest level of basic information on Australian water resources and of making it readily available.

The following paragraphs offer some comments on the sources of water, the methods of assessing water resources, and the role of various authorities, including the Australian Water Resources Council, involved in the assessment which is currently proceeding.

2. Sources of Water

The source of water can most generally be explained in terms of the hydrologic or water cycle. The cycle may be defined as the continuous movement of water between the ocean, the atmosphere and the land. This movement involves the physical processes of evaporation. transportation of water vapour in air masses, condensation leading to precipitation, the flow of water in streams and underground, and transpiration by vegetation.

Knowledge of the occurrence of water in the form of precipitation (rain and snow), rivers, streams and lakes and underground in the interstices of soils and rocks is a starting point in any inventory or assessment of resources. In Australia such an inventory broadly discloses that in this dry continent there is low and variable rainfall, high evaporation and low topography, with a dearth of cheap dam sites. Fortunately, underground water is fairly widespread both as pressure (artesian and sub-artesian) and non-pressure water.

3. Assessment and Measurement of Resources

(i) **General**

A comprehensive national assessment of a country's water resources must show in quantitative terms the availability of water and indicate the possibilities of development of these resources by modern technology to meet specific needs such as irrigation, hydro-electric power generation, and urban, rural and industrial water supplies. Rainfall, evaporation and other meteorological elements, surface water and underground water must be measured by observations extending over long periods of fifty or more years at fixed locations or stations. Measurement of the quality of the water, particularly in the case of underground water, is essential. Although analytical methods are available for estimating water resources, there is no real alternative to direct measurement as a basis for the planning of water development projects or for the design of culverts, bridges and flood mitigation and drainage projects.

The Commonwealth Bureau of Meteorology is primarily responsible, **inter afia**, for the measurement of rainfall in Australia. The Bureau currently maintains some 7,500 rain gauges, but it is estimated that over 13.000 are required to provide an adequate national network. A continuous record of the intensity of rainfall is made by an instrument called a pluviograph. About 500 of the existing 7,500 gauges are pluviographs and a further 1,200 pluviographs are estimated to be required.

(ii) **Surface Water**

Surface water is assessed wherever possible by direct measurement of river flow (discharge) at stream gauging stations. Various authorities in each of the States and the Commonwealth are responsible for the measurement of stream flow in Australia *(*see para. 4, p. 230). The stream gauging requirements of these authorities have been compiled by the Australian Water Resources Council *(*see para. 5, p. 230), and it is estimated that a basic network of about 2.800 gauging stations is required to provide for an adequate assessment of the surface water resources of Australia. At present some 1,300 gauges are installed. Current plans call for the completion of the basic network within ten years.

Basically, stream gauging entails (a) obtaining records of water levels and (b) establishing a relationship or “ rating” between the water level and the discharge.

Water levels can be recorded continuously by installing instruments at the gauging site. The discharge is obtained by visiting the site and measuring the velocity of the stream in vertical sections across the stream. Knowing the sectional area enables the discharge corresponding to the height of the stream at that particular time to be calculated. Measurement of the discharge over! a range of water levels enables a relationship between discharge and water level to be established. In order to determine this relationship it is necessary to carry out measurements at the gauging site over a range of discharge conditions including Periods of flood. “ Rating” of the station can therefore require many years of measurement under arduous conditions before the records of water level can be correlated with discharge.

(iii) **Underground Water**

The measurement of underground water is a more complex task than is the measurement of rainfall and river discharge. The location of water beneath the ground entails surface and sub-surface geological investigations including geophysical exploration and the drilling of bores. Measurement involves controlled pumping tests and, over long periods, recording of water levels in observation bores to indicate the effects of continued pumping and the recharge capabilities of the aquifier. Quality testing is an Important part of underground water investigations.

As in the case of surface water, the Water Resources Council has considered the deficiencies in underground water measurements, and many new underground water investigations extending

over wide areas have been commenced. However, the large area involved and the problems encountered in attempting to measure precisely water flow in rocks that it could be more than fifty years before knowledge of Australia's resources becomes adequate.

4. Authorities Responsible for Water Measurement

Surface and underground water resources are measured by both Commonwealth and State Government authorities. However, the greater part of the measurement programs are undertaken by State Government authorities. As previously mentioned, meteorology (e.g. rainfall and evaporation measurement) is primarily a Commonwealth Government responsibility.

Commonwealth Government authorities carry out gauging in the Northern Territory (Water Resources Branch, Northern Territory Administration), and in the Australian Capital Territory and the Territory of Papua and New Guinea (Department of Works). In the Snowy Mountains Area and the Murray River basin both Commonwealth and State Government authorities have interests in stream gauging. The Commonwealth Bureau of Meteorology maintains river height stations which are used solely for flood warning.

State Government authorities are responsible for stream-gauging in their respective States. The principal authorities in each State are as follows.

New South Wales: Water Conservation and Irrigation Commission..
Victoria: State Rivers and Water Supply Commission; State Electricity Commission.
Queensland: Irrigation and Water Supply Commission.
South Australia: Engineering and Water Supply Department.
Western Australia: Public Works Department.
Tasmania: Hydro-electric Commission; Rivers and Water Supply Commission
Underground water resources are investigated by a number of the authorities that have responsibilities for stream-gauging, and by State Departments of Mines and the Bureau of Mineral Resources of the Commonwealth Department of National Development. The following are the principal authorities in each State and Territory.

New South Wales: Water Conservation and Irrigation Commission; Department of Mines.
Victoria: Department of Mines.
Queensland: Irrigation and Water Supply Commission; Department of Mines.
South Australia: Department of Mines.
Western Australia: Department of Mines.
Tasmania: Department of Mines
Northern Territory: Water Resources Branch, Northern Territory Administration; Bureau of Mineral Resources.
Australian Capital Territory: Bureau of Mineral Resources.
Territory of Papua and New Guinea: Papua and New Guinea Administration; Bureau of Mineral Resources.

These authorities are assisted by various scientific and industrial foundations. In New South Wales, for example, the Hunter Valley Research Foundation is carrying out scientific investigations, including an integrated study of water, soils, and climate, in the catchment area of the Hunter River. In addition, the University of New South Wales recently formed the Water Research Foundation which has, among its objectives, research into underground water.

5. Australian Water Resources Coucil

The assessment of Australia's water resources entered upon a new phase with the establishment, by joint action of the Commonwealth and State Governments, of the Australian Water Resources Council in 1962. The Council comprises the Minister for National Development as Chairman, the Minister for Territories and the Ministers for Water Supply in each State. It has as its principal objective the provision on a continuing basis of a comprehensive assessment of Australian water resources and the extension of measurement and research so that future planning can be carried out on a sound and scientific basis.

An important factor is that the Council is not concerned with particular works projects, normally the responsibility of the States or the Commonwealth, for which there are established channels for the exchange of views and allocation of funds such as the Premiers' Conference and Loan Council.

Assisting the Council is a Standing Committee of senior officers from Commonwealth and State water authorities, and there are a number of committees advising the Committee, namely: Water Research and Education Steering Committee, Technical Committee on Surface Water, Technical Committee on Underground Water, Advisory Committee on Hydraulics Laboratory Facilities and several ad hoc panels.

The Water Resources Council has given close attention to a number of important matters which the more urgent are the publication of a **Review of Australia's Water Resources Stream Flow and Underground Resources**) 1963 (which was issued early in **1965**) and the recommendation of accelerated programs of stream-gauging and underground water investigations.

Australian Governments have adopted an accelerated program of stream-gauging (surface water measurement) to extend over the next ten years, and have recognised the need for a continuous program of underground water investigations. Under the **States Grants (Water Resources) Act 1964**, the Commonwealth Government grants financial assistance to the States in connection with the measurement and investigation of their water resources. This means that £1,846,000 of additional funds (a sixty per cent. increase on current rates of expenditure) could be made available over the next three years relative to these programs

All authorities represented on the Council and its committees have agreed to work towards a common, nation-wide system of recording hydrologic data in a digital form suitable for rapid analysis by computer. The Council is also giving attention to the extent to which particular kinds of water research, and specialised training of research workers, can assist in bringing about the comprehensive water resources assessment envisaged as the Council's objective.

6. National and International Aspects

1. General

As the Commonwealth Constitution makes special reference to water rights, both the Commonwealth and the State Governments have an interest in the control and conservation of water. The main responsibility for control of water resources rests with the individual State Governments, but as political boundaries sometimes intersect river valleys and catchments, cooperation between Governments has been necessary to develop resources in certain cases. Specific examples of Commonwealth-State and interstate cooperation and approach are given in the following paragraphs.

2. Australian Water Resources Council

For information regarding the constitution, establishment, functions and objects of the Australian Water Resources Council see §3**,** para. 5, p. 230.

3. Murray River Scheme

(i) General

The Murray River and its tributaries form the largest river system in Australia. The catchment is approximately 414,000 square miles, or one-seventh of the area of the Australian continent, comprising five-sixths of New South Wales, over one-half of Victoria, one-sixth of Queensland and one-fortieth of South Australia. The Murray proper is 1,600 miles long. Its main tributaries are the Darling (1,700 miles), the Murrumbidgee (980 miles), and the Goulburn *(350* miles). The average annual flow of each of the chief contributory streams is as follows: Upper Murray, including the Mitta Mitta and Kiewa Rivers, 3,623,000 acre feet; Darling River, 2,896,000 acre feet; Goulburn River (including Broken River), 2,570,000 acre feet; Murrumbidgee River, 2,054,000 acre feet; and Ovens River, 1,222,000 acre feet. Irrigated production in the Murray River Basin is mainly grapes for wine, dried fruits, fresh fruits, rice, vegetables, dairy produce, wool, and fat lambs.

(ii) River Murray Waters Agreement

For a brief summary of the historical events leading up to the River Murray Agreement (1915) by the Governments of the Commonwealth, New South Wales, Victoria, and South Australia, *see* issues of the Year Book prior to No. 39. Under the Agreement, construction works are carried out by the States (which are also responsible for maintenance) subject to the approval and direction of the River Murray Com-mission. The Agreement provides that the minimum quantity of water to be allowed to pass for supply to South Australia in each year shall be sufficient to maintain certain specified flows in the lower river varying from 47,000 acre feet a month in the winter months to 134,000 acre feet a month in the four summer months of maximum demand - the total amounting to 1,254.000 acre feet over twelve months. The flow at Albury is shared equally by New South Wales and Victoria, and each of these States has full control of its tributaries below Albury, subject in each case to the fulfilment of the South Australian allocation. For a brief outline of the operation of the Agreement prior to 1949, see Year Book No. 40, Page 1065, and earlier issues.

At a conference of Ministers held in 1949 to consider the diversion of the Snowy River it was decided that, by diversion of streams in the Snowy Mountains area, an average of approximately 440,000 acre feet per annum would be added to the Murray River (see Para. 5, Snowy Mountains Hydro-electric Scheme, p. 233) and that increased storage should be Provided in order to give additional regulation to the Murray River itself as well as to Provide for regulation of the diverted waters. Hydro-electric potentialities would also affect the size of the storage.

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